IB Phil. of Science   Transparencies   ①

1. What is Philosophy
2. Four Branches
3. Knowledge v. belief — Sources of Knowledge
4. Views on Science

1a. Observation → Theory   Theory → Explanation
1b. A Simple Picture of Science

1. Sense Experience → Knowledge
1a Distinction between Science, Common Sense
2.   Hume on Cause
3. 7 nus — Conditions   Mill def^n of cause
3a. Causation → counterfactuals.
4. Simple Models of Science , (Explanation, methods)
5. Types of Scientific Law
6. Humean view of Laws   6.A.) Ramsey-Lewis account.
7. Reasons v. Explanations.
8. Types of explanation
9. Deductive explanations of Laws
10. Enumerative induction
10a Eliminative induction.
11. Solutions to the problem of induction
       (a) Uniformity of Nature
       (b) Pragmatic Justification
       (c) Popper's solution   P.T.O

13.) <u>Mill's Method</u>   Joint

⑬a { Agreement   Residue

       { Difference   Concomitant Variation } ⑬2

14.) Problems with Mill's Methods

       Irrelevant factors

       Hidden factors

       Plurality of Causes

       Complexity of Causes.

12·15·) Paradoxes of Confirmation Theory

       The Raven Paradox.

       The Grue Paradox.

       Transitivity Paradoxes

15.) <u>Valid argument</u>

16.) <u>The logical particles</u>

16 cont). Symbol

17.) Sound argument

17 cont'd) Logical truth

       logical contradiction and

18) The Four views on logic

19) Language Terms, Sentences

20) Intension, Comprehension, Extension

21
22 Statements o Judgement
    + analytic proposition

22 Synthetic / analytic distinction
23
    ~~and the Synthetic a priori~~
    "Synthetic a priori"

23
24 Duhem Quine Thesis
    Lakatos Ed. of D-Q Thesis

25
    Crucial experiments
26
    The history of logic
27
    — Mathematical logic
28

29 The Syllogism.
30
    Syllogism — Moods o Figures
31 Moods.
32 33 34 35   Examples:

                        P.T.O

346 Truth Tables or , and , not .

347 Tautology Ex

368 Rabical implication .
       % P then Q , Truth Table.

369 Deduction Theorem

Ex decision procedure for arguments

<u>Methodologies</u>

1. Levels of factual knowledge
2. Falsification
3. Basic statements , falsification
4. Popperian criteria , schema
5. Verisimilitude
6.   certo
7.
8. Kuhn on progress of science
9. incommensurable verbal means
10. Lakatos
11. Feyerabend

(62)
<u>Transparencies</u>

WHAT IS PHILOSOPHY

Deals with ultimate Reality:

The analysis of concepts,
principles and presuppositions
underlying any branch of
knowledge.

Natural P.

Study of
objects and phenomena in
the physical world.

Moral P.

study of
principles of human
action or conduct.

FOUR BRANCHES

ONTOLOGY

What there is_ (i.e. exists)

Tables, chairs, electrons, quarks,
colours, numbers, minds,
squareness, beauty, God.....

EPISTEMOLOGY

How do we know_ what there is?
(and how it behaves etc)

LOGIC

How do we argue_ about
what there is?

ETHICS and AESTHETICS

How do we evaluate_ what there is?
good and bad (actions)
beautiful and ugly (objects etc.)

KNOWLEDGE

V. BELIEF

I know X

1) X is true

2.) I believe X

3.) My belief is based on adequate evidence

4.) If X were not true I would not believe X.

SOURCES OF KNOWLEDGE

Reason
sense experience
authority
Intuition
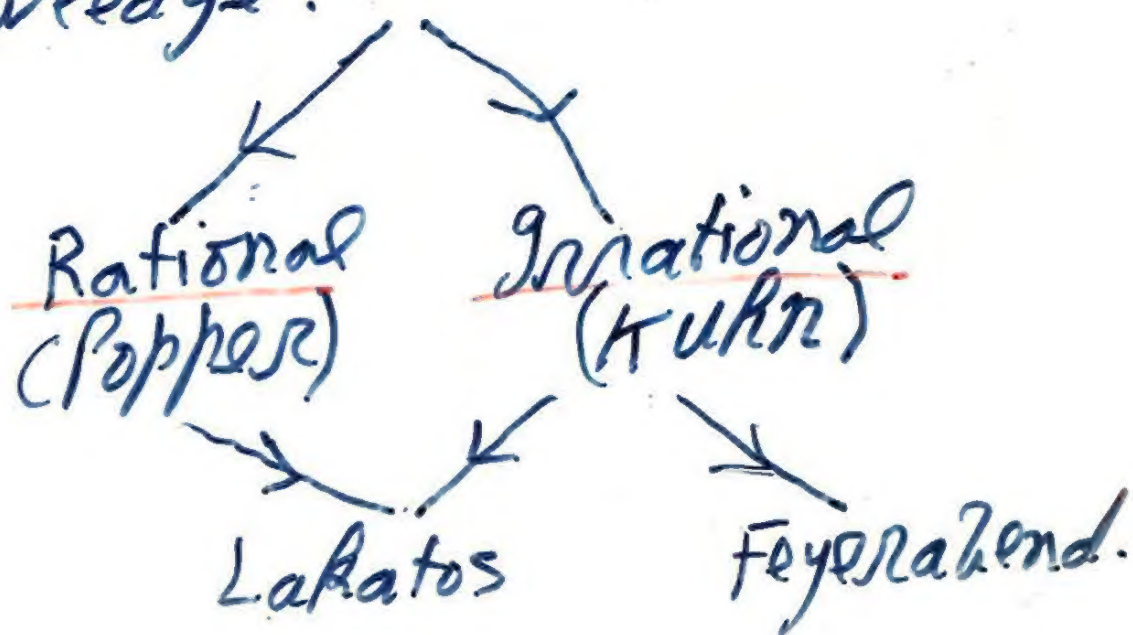Revelation
Faith

VIEWS ON SCIENCE (4)

ORTHODOX

Science gives certain or at
any rate probable knowledge

$\longrightarrow$ Inductivists

— Bucket approach.

UNORTHODOX

Science gives uncertain,
problematic or conjectural
knowledge.

Rational   Irrational
(Popper)   (Kuhn)

Lakatos   Feyerabend.

Distinction Between Science and Common Sense (C.S.)

1) C.S. not concerned with explanations

2) C.S. makes too extravagant claims

3) C.S. may be inconsistent

4) C.S. tends to survive longer than science

5) C.S. concerned with matters of practical importance.

HUME ON CAUSE

3 conditions:

1) Contiguity

2) Succession

3) constant conjunction

what about necessary connection?

Queries re ③

a) constant conjunction may
not signal causation.
ex traffic lights, night and
day etc

b) causation may not imply
constant conjunction
ex striking the match may
not always result in
an explosion

INUS condition

_In_sufficient but _n_ecessary part of an _un_necessary but _s_ufficient condition.

Mill's Definition of Cause

Total set of conditions sufficient invariably to produce the effect

Causation and Counterfactuals

If P were the case Q
would be the case

If P were *not* the case Q
would *not* be the case.

Then we can say
P causes Q

Problems :
Asymmetry
overdetermination
preemption

Simple Model of Science ④

Science is collection of
Causal laws of the form
P causes Q

Scientific Explanation of Q is to
affirm P causes Q _and_ that
P has occurred.

Scientific Method
Rules for arriving at P
for any given Q.

Types of Scientific Law

1) Properties attributed to 'Natural kinds'

2) Invariable sequential order
   a) non-causal
   b) causal.

3. Statistical laws

4. Laws of functional dependence.

   eg Boyle's law $PV = const.$

   Dynamical laws
   $$S = \frac{1}{2} g t^2.$$

Humean view of
Laws

Cosmic uniformities

1) Universally quantified over all particular instances

2) True

3) Contingent

4) Contains only general predicates

Query Is a river of Coca-Cola physically possible?

Laws as descriptive v. prescriptive
Subjunctive conditionals
Vacuously true laws   Ex Newton I

Limited laws   Ex Kepler's Laws

RAMSEY — LEWIS
ACCOUNT

A Humean Uniformity is a law of Nature if and only if it appears as a theorem (or axiom) in a true deductive system that achieves an optimum combination of simplicity and strength.

REASONS VERSUS EXPLANATIONS

The Earth is Round:
Why?

a) Why do you believe the earth is round?

Answer is a <u>Reason</u> for your belief

2) Why <u>is</u> the earth round?

Answer is an <u>explanation</u>

TYPES OF EXPLANATION

1.) Deductive – nomological (D-N)
    model for explaining:

 (a) a particular fact

 (b) a law

2.) Probalistic explanations

3) Functional or teleological
 explanation
  (cf The Anthropic Principle)

4.) Genetic explanations

EXPLANATION AND PREDICTION

Barometers and flagpoles
Earthquakes.

Deductive Explanations

1) The issue of circularity:
The explanandum should
not be the only evidence
for the explanans.

2) Several laws involved
in the explanans
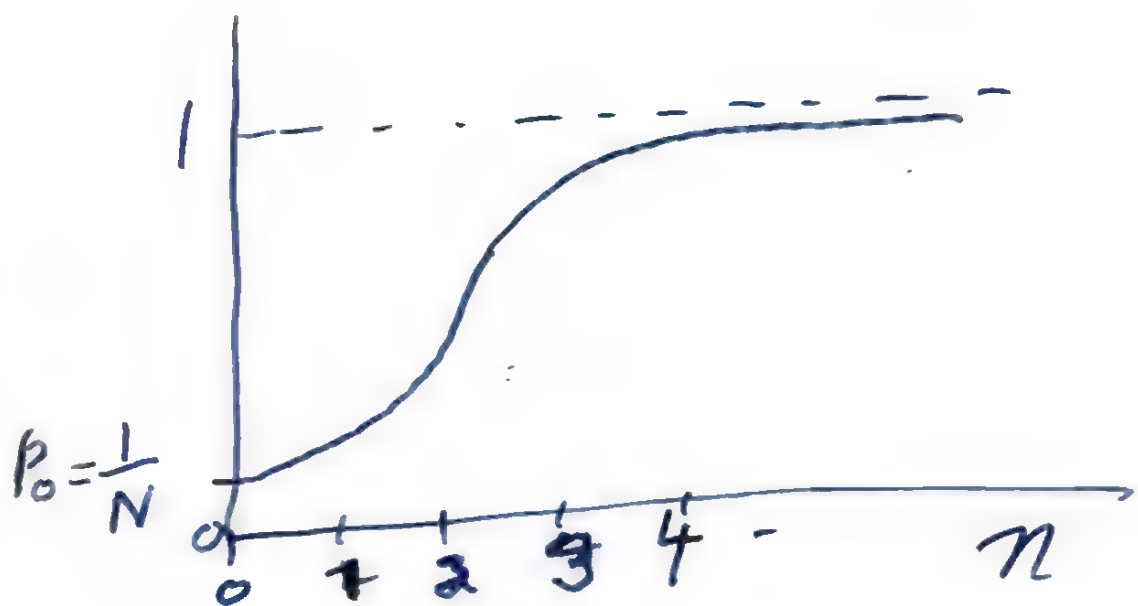
3) Depth and Unification

Enumerative Induction

$$P_n = F_n \times F_{n-1} \times \cdots F_1 \times P_0$$

Thus: $p(h \& e) = p(h/e) \cdot p(e) = p(e/h) \cdot p(h)$

But if $h \to e$, then $p(e/h) = 1$, so

$$p(h/e) = \frac{p(h)}{p(e)} \qquad \text{(Bayes' Theorem)}$$

But $p(e) = p(e/h) \cdot p(h)$
$$\qquad\qquad + p(e/\sim h) \cdot p(\sim h)$$
$$= p(h) + p(e/\sim h)(1 - p(h))$$

All swans are white

$$P_0 = \frac{1}{N} = \frac{1}{2^M}$$
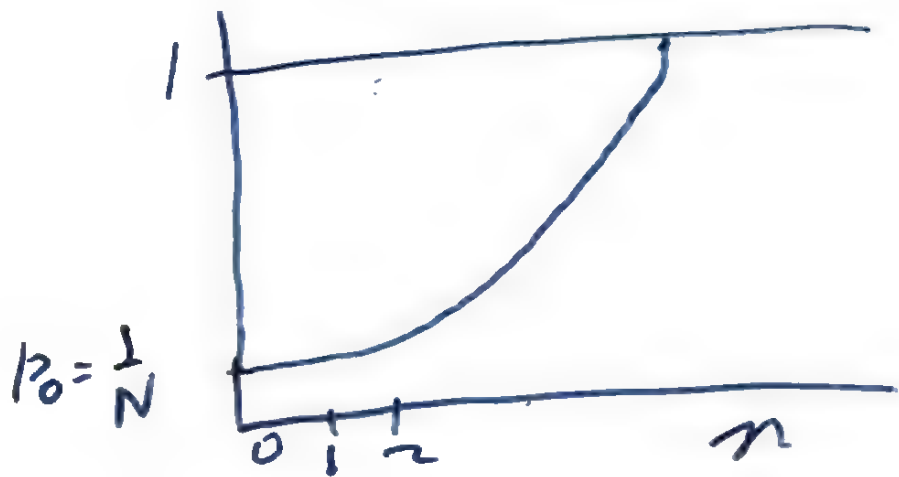
)

considering the first M swans

$$\rightarrow 0 \quad \text{as} \quad M \rightarrow \infty$$

then $P_n = F_n \times \cdots F_1 \times P_0 = 0$

This is Popper's argument.

Eliminative Induction

$$P_n = \frac{1}{N-n} \quad , \quad \text{so} \quad P_{N-1} = 1$$

SOLUTIONS TO THE PROBLEM OF INDUCTION

contd.

(a) Uniformity of Nature

(b) Pragmatic Justification

(c) Popper's solution

  — We don't need
     induction!

Paradoxes of Confirmation (12)

1. The Raven Paradox

2. The Grue Paradox

3. Transitivity Paradox

See M. Hesse:
The structure of
Scientific Inference
1974

MILL'S METHODS
OF EXPERIMENTAL
INQUIRY

(A System of Logic, 1843)

1. Method of Agreement
2. Method of Difference
3. Joint Method of Agreement and Difference
4. Method of Residues
5. Method of Concomitant Variation

Method of Agreement

If two or more instances of the phenomenon under investigation have only one circumstance in common, this circumstance in which alone all the instances agree, is the cause of the given phenomenon

Method of Difference

If an instance in which the phenomenon render investigation occurs, and an instance in which it does not occur, have every circumstance in common save one, that one occurring in the former; the circumstance in which alone the two instances differ in the cause, of an indispensable part of the cause, of the phenomenon.

Method of Residues

Subtract from any phenomenon such part as is known to be (by previous inductions) the effect of certain antecedents, and the residue of the phenomenon is the effect of the remaining antecedents.

Method of Concomitant Variation

Whatever phenomenon varies in any manner whenever another phenomenon varies in some particular manner is connected with it through some fact of Causation.

Problems with Mill's Methods

1. Irrelevant factors

2. Hidden factors

3. Plurality of Causes

4. Complexity of Causes.

Valid argument

Ex ① I entered through the
door or the window.

② I did not enter through the
window

∴ ③ I entered through the door

Extract the logical form of
the argument:

$$X \text{ or } Y$$
$$\text{not } Y$$
$$\therefore X$$

If you accept the premisses
then you are compelled to
accept the conclusion not in
virtue of the subject matter,
but in virtue of the meanings
of the logical particles <u>or</u>, <u>not</u>...

The logical particles

Connectives

and, or, if... then, not

quantifiers

all, some

copula 'is'.
Symbol of predication

N.B. In logic use inclusive
sense of word 'or'.

contrast:
① This student is lazy or stupid

② I like music or poetry

so $\quad X$ or $Y \equiv$ not(not$X$ and not$Y$)

and $\quad X$ and $Y \equiv$ not(not$X$ or not$Y$)

Also $\quad$ All men are mortal
$\equiv$ not(some men are not mortal)

__and__

Some men are mortal

$\equiv$ not (All men are not mortal)

__Symbols__

or	$\vee$
and	$\wedge$
not	$\sim$ or $\neg$
if --- then	$\supset$ or $\rightarrow$
All	$\forall$
Some	$\exists$

Ex   All men are mortal

$$\forall x \, (Mx \supset Mx)$$

Some men are mortal

$$\exists x \, (Mx \wedge Mx)$$

Sound Argument

is a valid argument with true premisses.

_so_ a sound argument delivers a true conclusion

_N.B._ This is not true of valid arguments per se.

A valid argument with _false_ premisses may have a true or a false conclusion.

The same is true for invalid arguments with either true or false premisses.

So truth or falsehood
of conclusion in an
argument is like this:

	Premises	
Argument	True	False
Valid	T	T or F
Invalid	T or F	T or F

Logical Truth

A proposition which is true
in virtue of the meanings
of the logical particles

Ex ① I am happy or I am   X or (not X)
        not happy

② All elephants are elephants
    $\forall x (Ex \supset Ex)$

Logical Contradiction

is the negation of a logical truth, i.e. it is necessarily false.

Ex. I am happy and I am not happy   X and (not X)

Four views on logical truth

1.) Psychological — laws of thought

2.) Platonic — objective meanings of the logical particles

3.) Very general laws of physics

4.) Instrumentalist conventions as to how we use the logical particles

Language and the World

LANGUAGE	Terms	Sentences
MENTAL REALM	concepts	propositions
PLATONIC WORLD	Ideas	Relations between Ideas
PHYSICAL WORLD	physical properties	states of affairs

The Meaning of a Term

① **Extension**

class of entities correctly
classified as exemplifying
the concept

② **Intension**

Collection of properties or
attributes <u>necessarily</u> and
<u>essentially</u> associated with the
objects which comprise the
extension

ex Man is a rational animal

A <u>statement</u> is the
affirmation of a proposition
i.e. a claim that it is true

A <u>Judgement</u> is the rational
assent to a proposition as
being true (to be distinguished
from mere belief)

An <u>Analytic</u> proposition is
one which is true in virtue
of the meaning of its constituent
terms and/or the logical
particles

<u>Ex</u> All Bachelors are
           unmarried

A Synthetic proposition is
one which is not analytic

What are our grounds for
believing a proposition
to be 'true'?

a posteriori   — Experience

a priori   — Independently
            of experience

Kind ⎰ analytic
of ⎱
knowledge ⎱ Synthetic

	a priori	a posteriori
analytic	✓	✗
Synthetic	?	✓

a priori   a posteriori
Source of knowledge

The Synthetic a priori

Rationalists   yes

Empiricists   no

Is there a clean distinction
between analytic and synthetic
propositions in Science?

Eus Caesar crossed the Rubicon

Ag melts at 960°C

Energy is conserved

The Duhem-Quine Thesis

Any particular proposition
in the nexus of propositions
constituting a Scientific
theory can be maintained
in the light of any possible
experience by making
appropriate changes in
other parts of the system.

Thus $H \cap h_1 \cap h_2 \cap h_3 \cdots \Rightarrow O$

Does not (O) allow us to
infer not (H) ?

In fact

$$\sim O \Rightarrow (\sim H) \vee (\sim h_1) \vee (\sim h_2)$$
$$\text{---}$$

Ex) $H \wedge h_1 \wedge h_2 \wedge h_3 \Rightarrow \sim O$

H : whenever a thread is pulled with a force exceeding that which characterizes its tensile strength it will break

h_1 : no other forces are acting other than attaching a weight.

h_2 : force characteristic for this thread is 1 lb wt.

h_3 : wt. put on the thread is 2 lb.

O : iron wt. of 2 lb was put on thread at space-time (location?) and it did not break.

Crucial experiments

$$H_1 \Rightarrow e$$

$$H_2 \Rightarrow \sim e$$

check whether e deems

if it does: H_2 is false

if it does not: H_1 is false

So e is a crucial observation to decide between H_1 and H_2.

History of Logic

Aristotle — Categorical Syllogisms

↓

Predicate logic (quantification)

Stoics — Propositional Logic

Boole — Algebraic Logic (1847)
(Schröder)

Frege — Predicate Logic (1879)
Logicism
(reduction of Mathematics to logic)

Russell, Whitehead

Principia Mathematica 3 vols. 1910-1913

Gödel 1931 Incompleteness Theorem.

Mathematical Logic

Two senses:

1. Logic exhibited as a formal axiomatic system

2. The logic required to do mathematics.

In the context of the logic required for science, we concentrate on 2 fragments of logic

syllogisms and Propositional logic

The Categorical Syllogism

All humans are mortal (major premiss)

All Athenians are human (minor premiss)

∴ All Athenians are mortal

(conclusion)

Extract logical form

All M's are P's

All S's are M's

∴ All S's are P's

M is the middle term.
we symbolize the argt. thus:

$$\frac{M - P}{S - M}$$
$$\overline{S - P}$$

1st Figure

How can we generalize?

① There are 4 figures

$$P - M$$
$$S - M$$
$$\overline{ }$$
$$S - P$$

2ⁿᵈ Figure

$$M - P$$
$$M - S$$
$$\overline{}$$
$$S - P$$

3ʳᵈ Figure

$$P - M$$
$$M - S$$
$$\overline{}$$
$$S - P$$

4ᵗʰ Figure

But there are also
$4 \times 4 \times 4 = 64$ Moods

(giving 256 syllogisms in all)

Moods

entropy

A   All $\underline{P}$ are $\underline{Q}$ } Universal

E   no $\underline{P}$ are $\underline{Q}$ }

I   Some $\underline{P}$ are $\underline{Q}$ } Particular

O   Some $\underline{P}$ are not $\underline{Q}$ }

So our first example is
   A A A in the 1st Figure

B$\underline{a}$r$\underline{b}$ar$\underline{a}$

A

$$P \cap \bar{Q} = 0$$
$$\forall x (Px \supset Qx)$$

E

$$P \cap Q = 0$$
$$\forall x (Px \supset \sim Qx)$$

I $\quad$

$P \cap Q \neq 0$

$\exists x \, (Px \land Qx)$

O $\quad$

$P \cap \bar{Q} \neq 0$
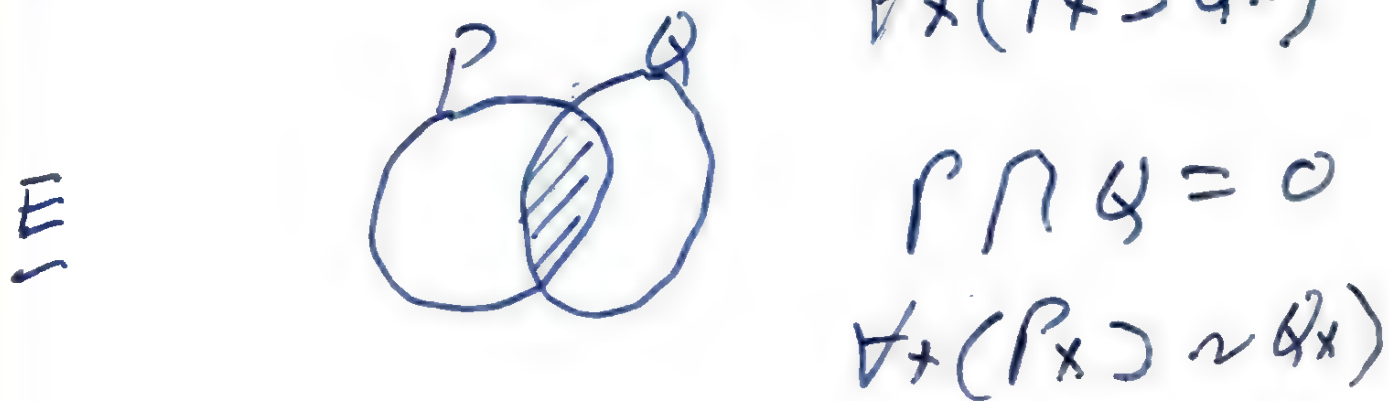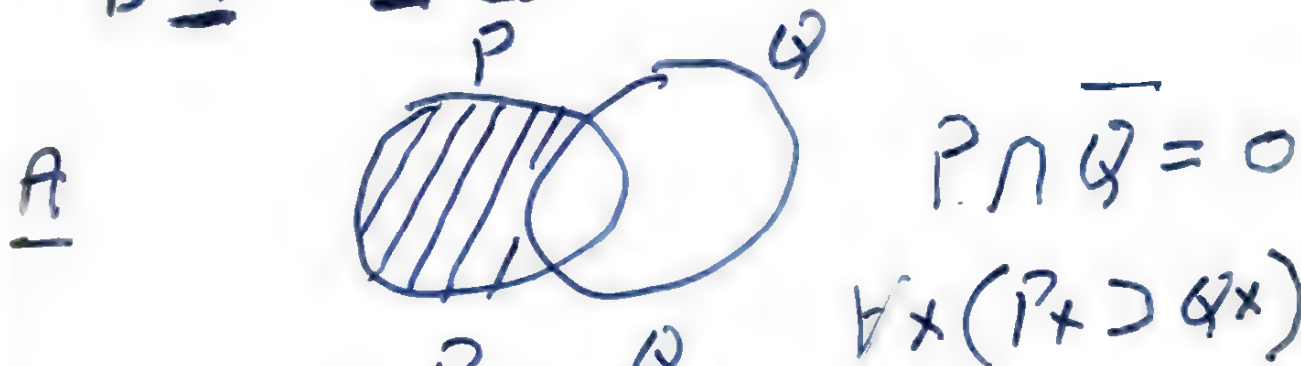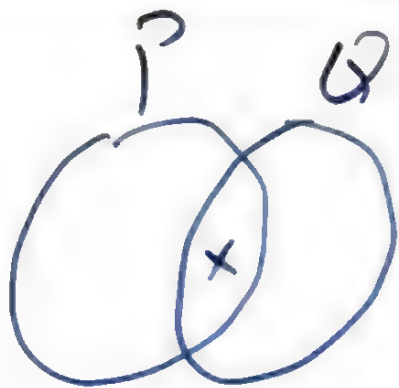
$\exists x \, (Px \land \sim Qx)$

Examples
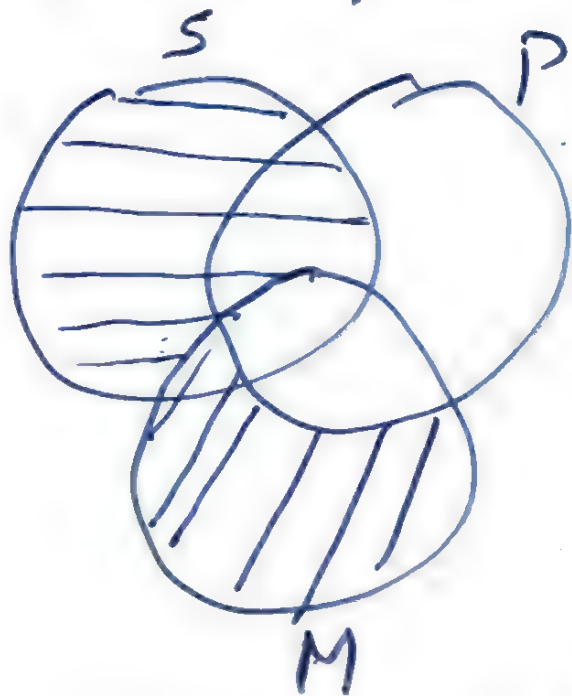
O A A A $\quad$ 1ST Figure

All M are P
All S are M
_____
All S are P

So Syllogism is valid.

(2) A I I   3rd Figure   (33)
Datisi

All M are P
Some M are S
─────────────
Some S are P
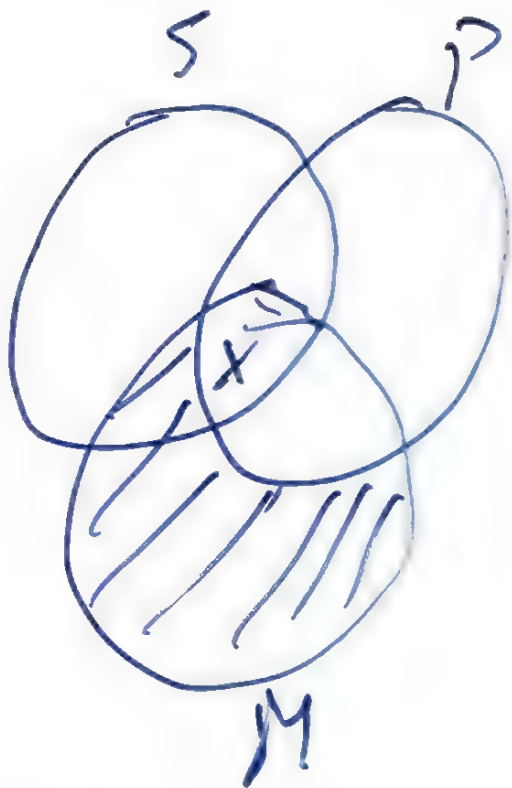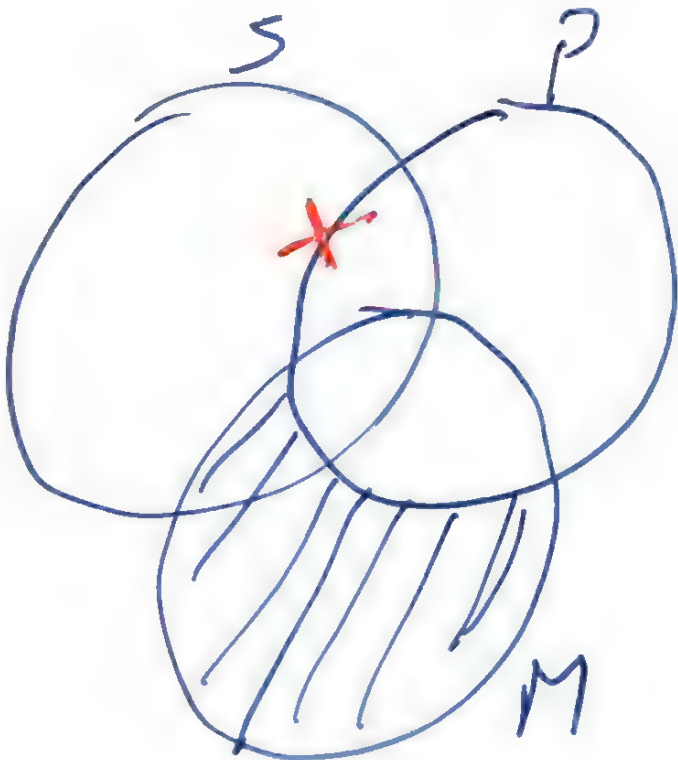

So Syllogism is Valid

All M are P
Some S are not M
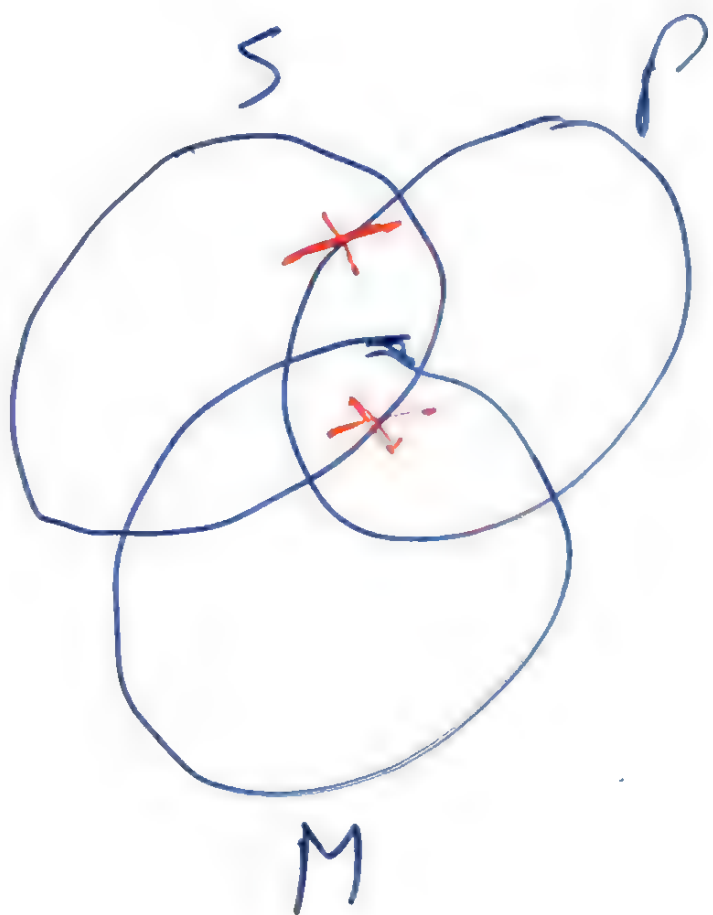---
All S are not P

Invalid

(4) IOO in 1st Figure

Some M are P.
Some S are not M

Some S are not P

Invalid

would require

conclusion

Propositional Logic

Truth Tables — or, and

p	q	p ∨ q	p ∧ q
T	T	T	T
F	F	F	F
T	F	T	F
F	T	T	F

not

p	~p
T	F
F	T

Tautology logical truth specialized to propositional logic

Ex. $p \lor (\sim p)$

p	$\sim p$	$p \lor (\sim p)$
T	F	T
F	T	T

Similarly $p \land (\sim p)$ is a logical contradiction

Implication statements

$$\text{If } p \text{ then } q$$

How are p and q related?

1. logical connection
2. Causal connection
3. Definitional connection
4. Decisional connection

What about

if chelsea wins the cup then
I am a monkey's uncle ?

Analyse $p \supset q$ as

$$\sim \left(p \wedge (\sim q) \right)$$

$$\equiv (\sim p) \vee q$$

or in terms of truth tables

p	q	$p \supset q$
T	F	F
F	F	T
F	T	T
T	T	T

Notice

If p is false then $p \supset q$ is always true.

Ex If a circle is square then God exists is a true proposition !

But also

If a circle is square then God does not exist !

Modus ponens	Modus tollens
$p \supset q$	$p \supset q$
p	$\sim q$
$\therefore q$	$\therefore \sim p$

The fallacy of affirming
the consequent

$$p \supset q$$
$$q$$
$$\therefore p$$

Invalid
argument

Deduction Theorem

$$p \vdash q \qquad \text{derivability}$$
$$p \vDash q \qquad \text{logical consequence}$$
$$\vDash q \qquad q \text{ is a tautology}$$

① $p \vdash q$ iff $p \vDash q$

soundness and
completeness

② $p \vDash q$ iff $\vDash (p \supset q)$

(Semantic Version of Deduction Theorem)

Levels of factual knowledge

0   Subjective experience

1   Singular statements about
     observable things & events

2.   Regularities displayed by ①

3.   Exact experimental laws

4.   Scientific Theories

Falsification

All swans are white

$$\forall x \, (S(x) \supset W(x))$$

$$\equiv \sim \exists x \sim (S(x) \supset W(x))$$

$$\equiv \sim \exists x \sim (\sim S(x) \vee W(x))$$

$$\equiv \sim \exists x \, (S(x) \wedge (\sim W(x)))$$

This is refuted by

$$\exists x \, (S(x) \wedge (\sim W(x)))$$

i.e. by Some swans are not white

Singular Predictive Implication (SPI)

$$S(k) \supset W(k) \equiv \sim (S(k)) \vee W(k)$$
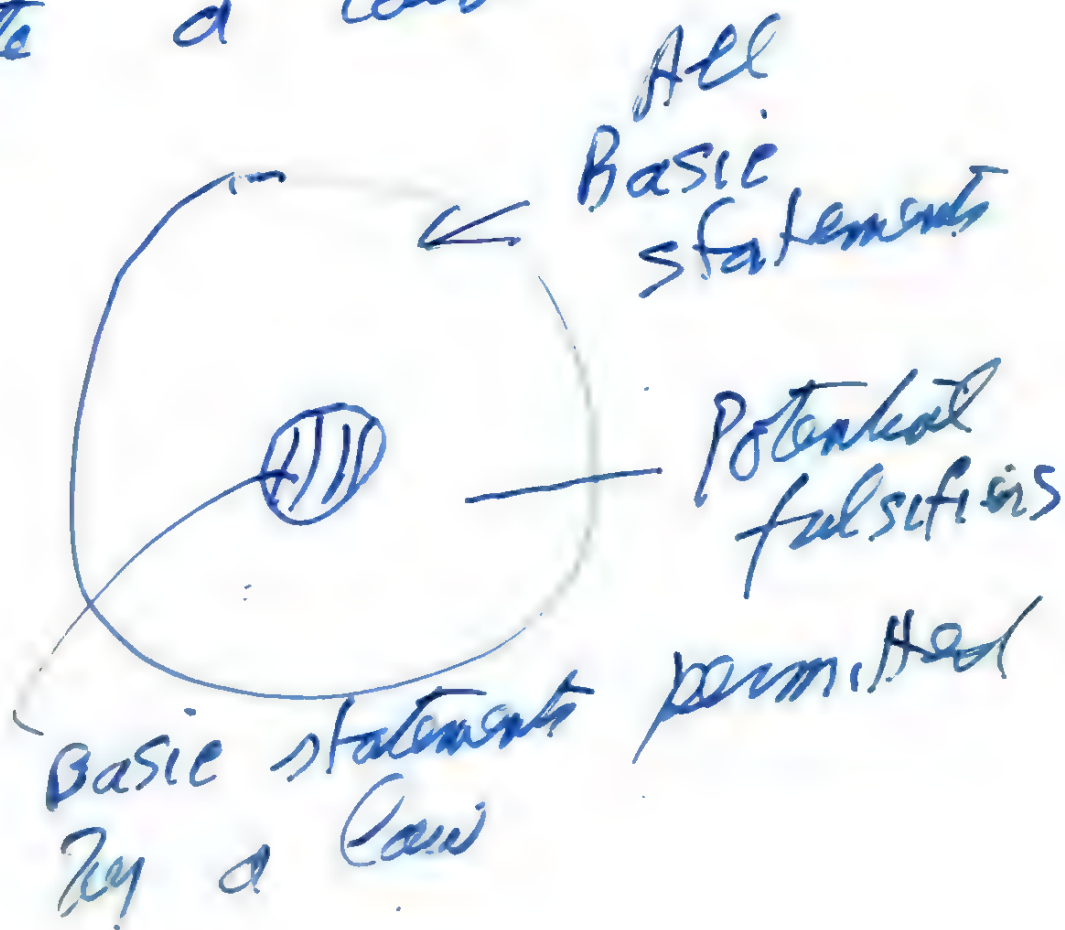
Potential falsifier $\sim$ (SPI)

$$\equiv S(k) \wedge (\sim W(k))$$

Basic statement

Singular existential statement which is of right logical form to refute a universal law

Potential falsifier

Basic statement which does refute a law

All Basic statements

Potential falsifiers

Basic statements permitted by a law

For Popper a theory should be: (4)

	Feature	Reason
a)	Testable	Scientific
b)	lead to novel predictions	corroborable
c)	be corroborated	increase in verisimilitude

Popper schema

$$P \rightarrow TT \rightarrow EE \rightarrow P'$$

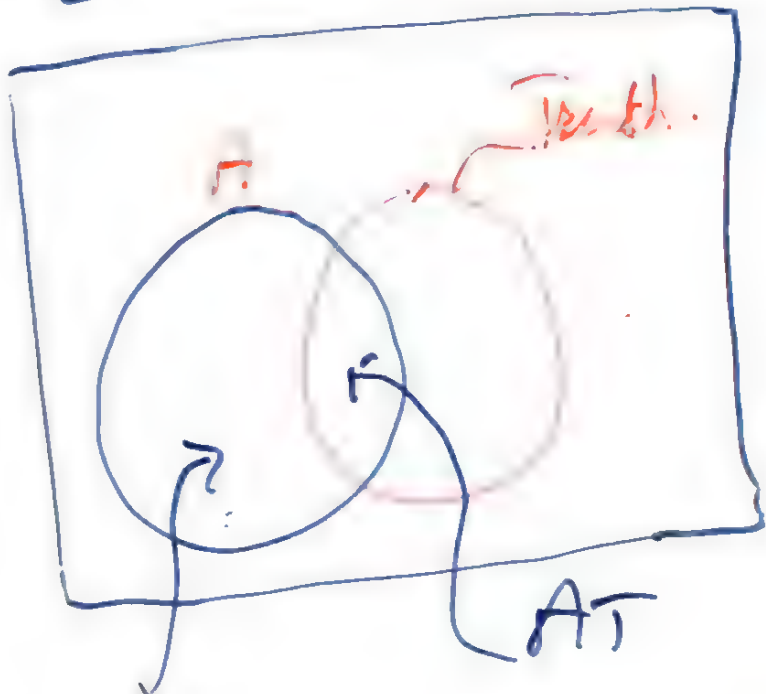Problem   Tentative Theory   Error elimination   new problem
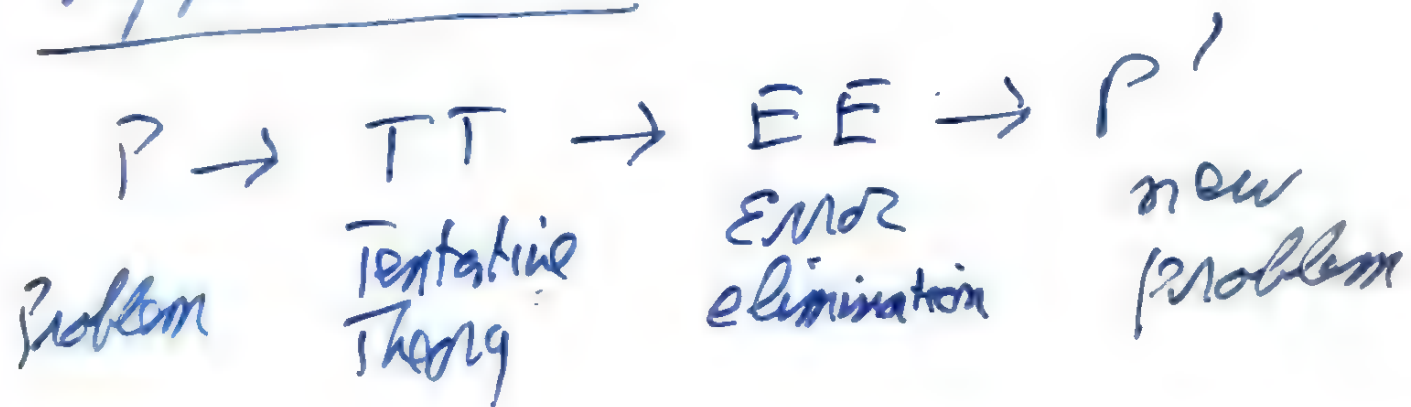
Verisimilitude

$$= m(\text{Truth Content})$$
$$- m(\text{Falsity Content})$$

So $V(A) = m(A_T) - m(A_F)$

$A_T = \{\text{True consequences of } A\}$
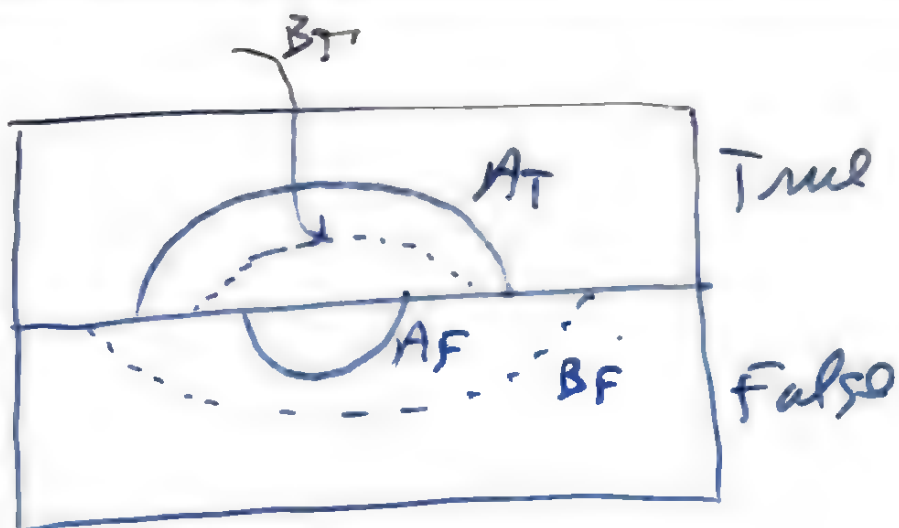
$A_F = \{\text{False consequences of } A\}$

F is any false consequence of A.

But if we add S to A_T, we also add $S \cap F$ to A_F, and if we take away S' from A_F, we also take away $S' \vee S'$ from A_T

A diagram with a rectangle divided by a horizontal line. The upper portion is labeled "True" and the lower "False". Inside are nested ovals labeled A_T (upper), B_T (pointed to from top), A_F and B_F (lower).

Then $V(A) > V(B)$

But this situation is not possible

Ex   A: It is now between 9.45 & 9.48
                               9.40 & 9.48
     B: - - - - - - - -

Truth :   It is now 9.50.

A_T all sentences of form: It is now between x & y where $x < 9.45$, $y > 9.50$
Similarly for B_T where $x < 9.40$, $y > 9.50$
Clearly $B_T \subset A_T$, but $A_F \not\subset B_F$
because A itself is a member of A_F
which is not in B_F!

Consider 2 astronomical theories:

$P =$ n° of planets

$D =$ n° of days in the week.

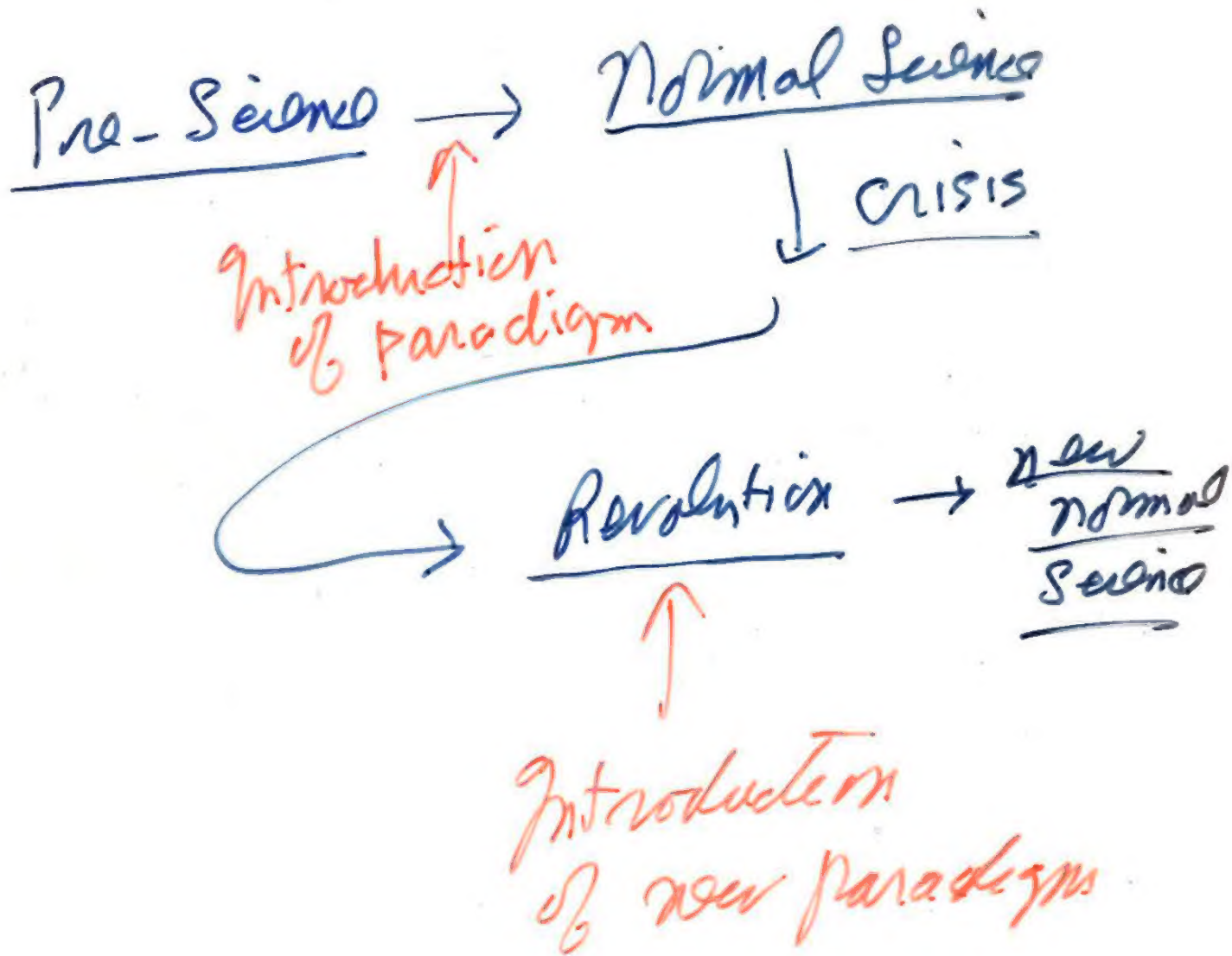|	$\frac{P}{9}$	$\frac{D}{7}$	$\frac{P+D}{16}$
Truth	$\frac{P}{9}$	$\frac{D}{7}$	16
A	11	5	16
B	9	5	14

Is $V(B) > V(A)$?

<u>yes</u> on basis of P & D

<u>no</u> on basis of P, D & $P+D$

KUHN

Pre-Science $\longrightarrow$ Normal Science

$\downarrow$ Crisis

Introduction of Paradigm

$\longrightarrow$ Revolution $\longrightarrow$ new normal Science

Introduction of new Paradigm

Senses of Paradigm

1. Sociological
2. Metaphysical
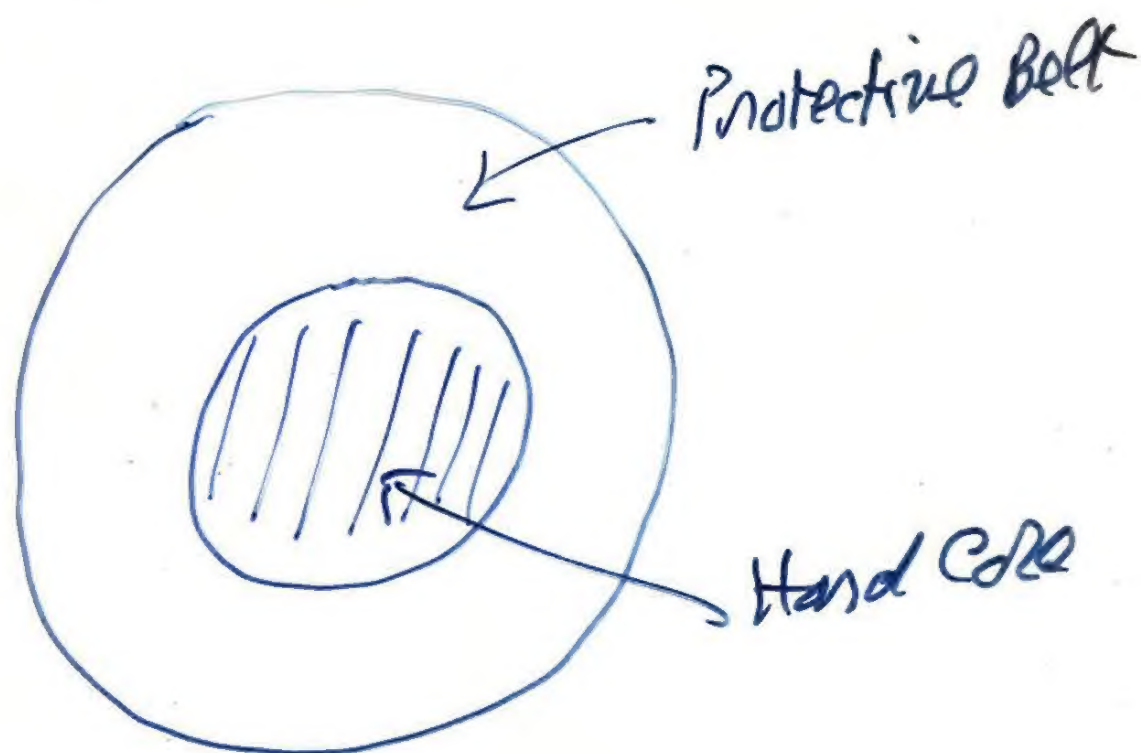3. Artefact Paradigm

Incommensurable world views

1. Different ontology.

2. Different sorts of question
   are _meaningful_ and
   legitimate

DUCK →

RABBIT ←

Does "Rabbits eat lettuce"
contradict
"Ducks do not eat lettuce" ?

Methodology of Scientific Research Programmes (MSRP)

Protective Belt

Hard Core

Positive Heuristic

A "research policy" for articulating
the protective belt and so
developing a succession of theories
in the Programme.

Negative Heuristic — Do not change
the hard core.

F.E. YERABEND

PLURALISM

1. Methodological
2. Theoretical
3. Idealogical

1. Methodological